Problem 3B.11

Radial flow between two coaxial cylinders. Consider an incompressible fluid, at constant temperature, flowing radially between two porous cylindrical shells with inner and outer radii κR and R.

(a) Show that the equation of continuity leads to $v_r = C/r$, where C is a constant.

(b) Simplify the components of the equation of motion to obtain the following expressions for the modified-pressure distribution:

$$\frac{d\mathscr{P}}{dr} = -\rho v_r \frac{dv_r}{dr} \quad \frac{d\mathscr{P}}{d\theta} = 0 \quad \frac{d\mathscr{P}}{dz} = 0 \tag{3B.11-1}$$

(c) Integrate the expression for $d\mathscr{P}/dr$ above to get

$$\mathscr{P}(r) - \mathscr{P}(R) = \frac{1}{2}\rho[v_r(R)]^2 \left[1 - \left(\frac{R}{r}\right)^2\right] \tag{3B.11-2}$$

(d) Write out all the nonzero components of $\boldsymbol{\tau}$ for this flow.

(e) Repeat the problem for concentric spheres.